DRAFT
TOTAL MAXIMUM DAILY LOAD (TMDL)

For

Fecal and Total Coliform

In

Tampa Bay Basin

(Includes TMDLs for Rocky Creek, Brooker Creek, Roosevelt Basin: Channel 2, Long Branch and Delaney Creek)

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AWT	Advanced Waste Treatment
BMP	Best Management Practices
BPJ	Best Professional Judgment
CFS	Cubic Feet per Second
CFU	Colony Forming Unit
DEM	Digital Elevation Model
DMR	Discharge Monitoring Report
EPA	Environmental Protection Agency
F.A.C.	Florida Administrative Code
GIS	Geographic Information System
HUC	Hydrologic Unit Code
LA	Load Allocation
MGD	Million Gallons per Day
MOS	Margin of Safety
MPN	Most Probable Number
MS4	Municipal Separate Storm Sewer Systems
NASS	National Agriculture Statistics Service
NLCD	National Land Cover Data
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
OSTD	Onsite Sewer Treatment and Disposal Systems
PLRG	Pollutant Load Reduction Goal
Rf3	Reach File 3
RM	River Mile
STORET	STORage RETrieval database
TMDL	Total Maximum Daily Load
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WBID	Water Body Identification
WCS	Watershed Characterization System
WLA	Waste Load Allocation
WMP	Water Management Plan
WRF	Water Reclamation Facility

SUMMARY SHEET
FOR EPA DEVELOPED Total Maximum Daily Load (TMDL)

1. 303(d) Listed Waterbody Information

State: Florida

Major River Basin: Hillsborough (HUC 03100205), and Tampa Bay (HUC 03100206)

Impaired Waterbodies for TMDLs (1998 303(d) List):

WBID	Segment Name and Type	River Basin	County	Constituent(s)
1507	Rocky Creek (fresh water)	Tampa Bay	Hillsborough	Fecal Coliform
1474	Brooker Creek (fresh water)	Tampa Bay	Pinellas and Hillsborough	Fecal Coliform
1624	Roosevelt Basin: Channel 2 (marine water)	Tampa Bay	Pinellas	Total Coliform

2. TMDL Endpoints (i.e., Targets)

Class III Waters (fresh and marine):

Fecal Coliforms: 400 MPN/100mL

Total Coliform: 2400 MPN/100mL

3. Fecal Coliform Allocation:

WBID	$WLA_{Continuous}$	WLA_{MS4} (reduction)	LA (cfu/day)	TMDL (cfu/day)	Reduction
1507	1.95×10^{10} (see note 2)	57%	3.33×10^{10}	5.28×10^{10}	57%
1474	N/A	72%	1.77×10^{10}	1.77×10^{10}	72%

Notes:

1. N/A = not applicable
2. River Oaks and NW Regional AWT facilities discharges into Channel A near the downstream end of WBID 1507 below stations used to develop the TMDL, and do not impact the overall loads. Using end-of-pipe permit limits,the WLA for River Oaks is 9.46×10^{9} cfu/day and the WLA for NW Regional is 4.73×10^{9} cfu/day.

4. Total Coliform Allocation:

WBID	$WLA_{Continuous}$	WLA_{MS4} (reduction)	LA	TMDL	Reduction
1624	N/A	40%	40%	40%	40%

Note: N/A = not applicable

5. Endangered Species (yes or blank): Yes

6. EPA Lead on TMDL (EPA or blank): EPA

7. TMDL Considers Point Source, Nonpoint Source, or both: Both

8. Major NPDES Discharges to surface waters addressed in TMDLs:

Facility Name	NPDES No.	Facility Type	Impacted Stream
Dale Mabry	FL0036820	AWT	Brushy Creek (tributary to Rocky Creek)
River Oaks	FL0027821	AWT	Rocky Creek Channel A
NW Regional WRF	FL0041670	AWT	Rocky Creek Channel A

TOTAL MAXIMUM DAILY LOAD (TMDL)
FECAL AND TOTAL COLIFORM IN TAMPA BAY BASIN

1. INTRODUCTION

Section 303(d) of the Clean Water Act requires each state to list those waters within its boundaries for which technology based effluent limitations are not stringent enough to protect any water quality standard applicable to such waters. Listed waters are prioritized with respect to designated use classifications and the severity of pollution. In accordance with this prioritization, states are required to develop Total Maximum Daily Loads (TMDLs) for those water bodies that are not meeting water quality standards. The TMDL process establishes the allowable loadings of pollutants or other quantifiable parameters for a waterbody based on the relationship between pollution sources and in-stream water quality conditions, so that states can establish water quality based controls to reduce pollution from both point and non-point sources and restore and maintain the quality of their water resources (USEPA, 1991).

The State of Florida Department of Environmental Protection (FDEP) developed a statewide, watershed-based approach to water resource management. Under the watershed management approach, water resources are managed on the basis of natural boundaries, such as river basins, rather than political boundaries. The watershed management approach is the framework DEP uses for implementing TMDLs. The state's 52 basins are divided into 5 groups. Water quality is assessed in each group on a rotating five-year cycle. The Group 2 basin includes waters in the Apalachicola River basin, Apalachicola Bay, Chipola River basin, Hillsborough River basin and Tampa Bay basin. Group 2 waters were first assessed in 2001 with plans to revisit water management issues in 2006. FDEP established five water management districts (WMD) responsible for managing ground and surface water supplies in the counties encompassing the districts. The Hillsborough and Tampa Bay basins are in the Southwest Florida Water Management District (SWFWMD).

For the purpose of planning and management, the WMDs divided the district into planning units defined as either an individual primary tributary basin or a group of adjacent primary tributary basins with similar characteristics. These planning units contain smaller, hydrological based units called drainage basins, which are further divided into "water segments". A water segment usually contains only one unique waterbody type (stream, lake, cannel, etc.) and is about 5 square miles. Unique numbers or waterbody identification (WBIDs) numbers are assigned to each water segment.

2. PROBLEM DEFINITION

Florida's final 1998 Section 303(d) list identified numerous WBIDs in the Tampa Bay basin as not supporting water quality standards (WQS). After assessing all readily available water quality data, EPA is responsible for developing fecal and total coliform TMDLs in three WBIDs (see Table 1). The geographic locations of these TMDLs are shown in Figure 1. The TMDLs addressed in this document are being established pursuant to EPA commitments in the 1998 Consent Decree in the Florida TMDL lawsuit (Florida Wildlife Federation, et al. v. Carol Browner, et al., Civil Action No. 4: 98CV356-WS, 1998).

Table 1. Fecal and Total Coliform TMDLs Developed By EPA in Tampa Basin

WBID	Name	Planning Unit	Parameter of Concern
1507	Rocky Creek	Tampa Bay	Fecal Coliform
1474	Brooker Creek	Tampa Bay	Fecal Coliform
1624	Roosevelt Basin: Channel 2	Tampa Bay	Total Coliform

The waterbodies listed in Table 1 are designated as Class III waters. The designated use of Class III waters is recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife. Class III waters are further categorized based on fresh or marine waters. Water quality criteria for fecal and total coliform do not vary between Class III fresh or marine waters.

To determine the status of surface water quality in the state, three categories of data – chemistry data, biological data, and fish consumption advisories – were evaluated to determine potential impairments. The level of impairment is defined in the Identification of Impaired Surface Waters Rule (IWR), Section 62-303 of the Florida Administrative Code (F.A.C.). The IWR defines the threshold for determining if waters should be included on the state's planning list and verified list. Potential impairments are determined by assessing whether a waterbody meets the criteria for inclusion on the planning list. Once a waterbody is on the planning list, additional data and information will be collected and examined to determine if the water should be included on the verified list.

The format of this report is as follows: Chapter 3 is a general description of the impaired watersheds; Chapter 4 describes the water quality standard and target criteria for the TMDLs; and Chapter 5 describes the development of the coliform TMDLs. Water quality data collected in the WBIDs identified in Table 1 are presented in Appendix A. Details of TMDL calculations are provided in Appendix B.

In addition to the TMDLs listed in Table 1, EPA is proposing TMDLs developed by FDEP for the following pollutant and waterbodies in the Tampa Bay basin:

- Fecal Coliform in Roosevelt Basin: Channel 2 (WBID 1624)
- Fecal and Total Coliform in Long Branch (WBID 1627)
- Fecal and Total Coliform in Delaney Creek (WBID 1605)

FDEP was the primary author of these TMDL as indicated in the various reports. FDEP could not submit these TMDLs to EPA for approval/disapproval action in the allocated timeframe provided in the Consent Decree. However, FDEP is continuing the process of establishing these TMDLs to submit to EPA for approval/disapproval action. It is EPA's expectation that FDEP will establish the TMDLs included in this document and submit to EPA in the near future. At this time, EPA proposes these TMDLs under V.A.1 of the Consent Decree. References to FDEP developed TMDLs are located in Appendix C through E. The remainder of this document is specific to the TMDLs developed by EPA.

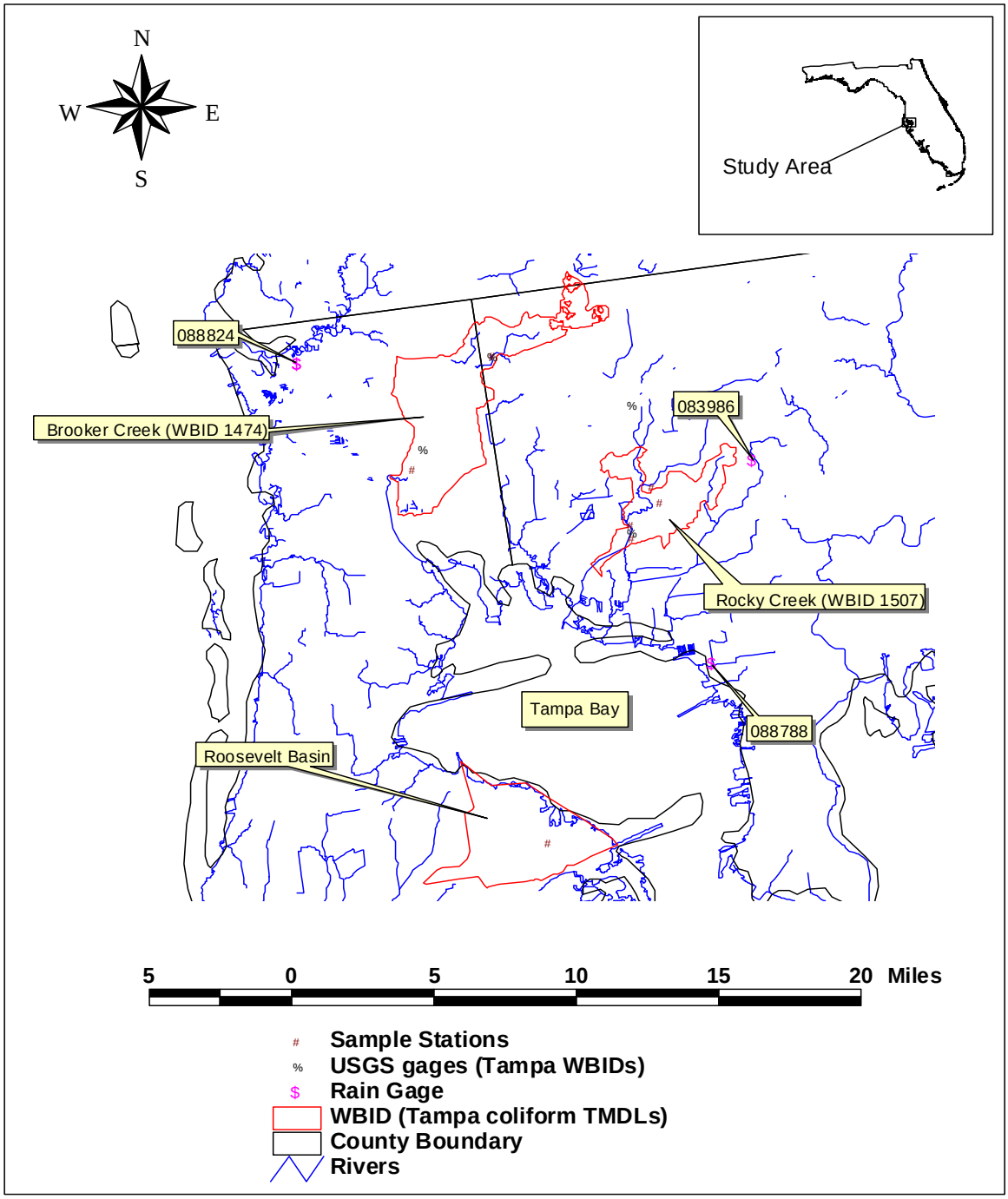

Figure 1. Location of WBIDs in Tampa Basin Impaired by Coliforms

3. WATERSHED DESCRIPTION

The Tampa Basin is defined by HUC 03100205 (Hillsborough River), 03100202 (Manatee River), and 03100206 (Tampa Bay). The following description of the impaired watersheds is from the Basin Status Reports (FDEP, 2001, 2002). These documents should be consulted for additional details.

The Tampa basin is divided into two groups: 1) the bay and the major tributaries that contribute surface water flows to the bay; and 2) a second group of major tributaries to the bay including the Hillsborough, Alafia, Little Manatee and Manatee Rivers. Tampa Bay is a Group 1 basin whereas the major tributaries are included in the Group 2 basin assessment. The TMDLs described in this document are impaired waters within the Group 1 basin.

Brooker Creek and Rocky Creek drain the area north of Old Tampa Bay and receive runoff from the municipalities north of Tampa. The drainage areas are within the Pinellas County MS4 jurisdiction. Portions of these creeks have been channelized and contain control structures to regulate freshwater flow and prevent saltwater intrusion. Land use in Brooker and Rocky creeks is predominately urban. In the upstream areas of Brooker Creek, land use is predominately agriculture and forest (see Table 2).

WBID 1624 entitled Roosevelt Basin: Channel 2 is a marine waterbody segment on the southwest shore of Old Tampa Bay and on the east side of the Clearwater/St. Petersburg peninsula. WBID 1624 is located within the Pinellas County MS4 jurisdiction. The WBID has been channelized into three sub-basins, which discharge directly into Old Tampa Bay. Coliform violations were measured in the Channel 2 sub-basin, which receives drainage from the south central portion of the WBID. The Channel 2 sub-basin receives stormwater runoff from light industrial, commercial, transportation land covers as well as runoff from a large landfill along the western side of the sub-basin. Site visits conducted in 2004 characterized Channel 2 as an unlined linear stormwater ditch with no discernable flow. It is likely Channel A only flows in response to precipitation events and coliform exceedences are associated with stormwater runoff. Based on available conductance data, Channel A shows tidal influence. Land cover in WBID 1624 is predominately urban in nature (i.e., roads, residential, and commercial, industrial and public areas) and accounts for about 60% of the land use in the WBID (see Table 2). In 2004, FDEP developed a fecal coliform TMDL for WBID 1624 (FDEP, 2004). This document provides a detailed description of the watershed characterization and source assessment.

Table 2. Land Cover Distribution[1] (acres)

WBID	Residential	Com, Ind, Public	Agriculture	Rangeland	Forest	Water	Wetlands	Transp and utilities	Barren&extractive	Total (acres)
Hillsborough River - Tampa Bay										
1507	2408.50	951.82	295.06	144.82	103.61	305.34	853.25	14.43	402.25	5479.07
1624	1352.01	2307.02	24.73	36.35	403.73	962.52	2224.34	1972.08	68.96	9351.74
1474	3151.67	676.28	1866.35	461.72	2030.37	564.47	4074.87	70.25	199.46	13095.43

Notes:
1. Acreage represents the land use distribution in the impaired WBID and not the entire drainage area.
2. Public lands include urban and recreational areas.
3. Rangeland includes shrubland, grassland, and herbaceous land covers.
4. Data source for the Hillsborough River –Tampa Bay basin is land cover of 1999 from the SWFWMD.

4. WATER QUALITY STANDARD AND TARGET IDENTIFICATION

Waterbodies in the impaired WBIDs are classified as Class III waters. The designated use classification for Class III waters is recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife. The water quality criteria for protection of Class III waters are established by the State of Florida in the Florida Administrative Code (F.A.C.), Section 62-302.530. The individual criteria should be considered in conjunction with other provisions in water quality standards, including Section 62-302.500 F.A.C. [Surface Waters: Minimum Criteria, General Criteria] that apply to all waters unless alternative or more stringent criteria are specified in F.A.C. Section 62-302.530. In addition, unless otherwise stated, all criteria express the maximum not to be exceeded at any time. The specific criteria addressed in this document are as follows:

Fecal Coliform Bacteria (Class III Waters)

The most probable number (MPN) or membrane filter (MF) counts per 100 ml of fecal coliform bacteria shall not exceed a monthly average of 200, nor exceed 400 in 10 percent of the samples, nor exceed 800 on any one day. Monthly averages shall be expressed as geometric means based on a minimum of 10 samples taken over a 30-day period.

When flow data are available in the WBID, the fecal coliform TMDLs are expressed as daily loads in units of counts per day. The target for the TMDLs is the 10 percent not to exceed criteria, as this is the more stringent of the acute criteria.

The fecal coliform TMDLs are also expressed in terms of the percent reduction required to achieve water quality standards. When flow data are not available in the WBID or due to geologic conditions it is not possible to estimate flow (i.e., karst geologic formation), the TMDLs are expressed only as percent reductions. The percent reduction is calculated using both the 400 criteria.

It is appropriate to use the more stringent of the acute criteria for fecal coliform TMDL development as the data indicates violations of the standard are typically related to storm events, which are short-term in nature. Violations of the chronic criteria are typically associated with point sources or non-point source continuous discharges (e.g., leaking septic systems) and typically occur during all weather conditions. Targeting the acute criteria should be protective of the chronic criteria.

Total Coliform Bacteria (Class III Waters)

The MPN per 100 ml of total coliform bacteria shall be less than or equal to 1,000 as a monthly average nor exceed 1,000 in more than 20 percent of the samples examined during any month, and less than or equal to 2,400 at any time. Monthly averages shall be expressed as geometric means based on a minimum of 10 samples taken over a 30-day period.

The target for the total coliform TMDLs is the one-day maximum concentration of 2400 counts/100mL, as less than 10 samples were collected in a 30-day period to determine violations of the not to exceed percentage criterion or the geometric mean. Total coliform bacteria generally indicate the presence of soil-associated bacteria and result from natural influences on a water body such as rainfall runoff as well as sewage inflows (i.e., acute conditions). By protecting the acute criteria (i.e., one-day maximum) bacteria concentrations in the stream should meet the chronic

criteria.

5. FECAL AND TOTAL COLIFORM TMDLS

This section of the report details the development of the coliform TMDLs. Fecal coliforms are a subset of the total coliform group and indicate the presence of fecal material from warm-blooded animals. Total coliform bacteria generally indicate the presence of soil-associated bacteria and result from natural influences on a water body such as rainfall runoff as well as sewage inflows.

5.1 WATER QUALITY ASSESSMENT AND DEVIATION FROM TARGET

FDEP maintains ambient monitoring stations throughout the basin. All data collected at monitoring stations within the impaired WBID are used in the analysis. Table 3 provides a list of the monitoring stations. Data collected during the Group 1 listing cycle (i.e., January 1995 through December 2002) and any data collected in 2004, if available, are considered in the data assessment.
Table 4 and Table 5 provide a statistical summary of the data and include the percent of samples that deviate from the target. A listing of all monitoring stations, measured coliform concentrations, and graphics showing all data collected in the WBID with respect to the target are included in Appendix A.

Table 3. Monitoring Stations used in the Development of Coliform TMDLs

WBID	Station Name	Parameter Evaluated	Available Sampling Period	Number Samples
1507 (Rocky Creek)	112WRD 02307000	Fecal Coliform	12/5//95 – 11/17/03	8
	21FLTPA 280223708234300	Fecal Coliform	9/9/03 – 12/16/03	4
	21FLTPA 280305908233390	Fecal Coliform	9/9/03 – 12/16/03	4
	21FLTPA 280357008233568	Fecal Coliform	9/9/03 – 12/16/03	4
	Rocky Cr @ Gunn Hwy (RO07)	Fecal Coliform	2/24/03 – 4/24/03	2
	Rocky Cr @ Mushinski Rd (RO08)	Fecal Coliform	2/24/03 – 4/24/03	2
	Rocky Cr @ Linebaugh Ave.(RO09)	Fecal Coliform	2/24/03 – 4/24/03	2
1474 (Brooker Creek)	21FLPDEM04-02	Fecal Coliform	1/25/95 – 12/17/96	22
	21FLPDEM04-03	Fecal Coliform	1/25/95 – 12/17/96	26
1624 (Roosevelt Basin: Channel 2)	21FLDEM23-01	Total Coliform	1/11/95 – 12/17/96	19

Table 4. Summary of Fecal Coliform Monitoring Data

WBID	Number of Samples	30-Day Geometric Mean[1]	% Samples > 400 (MPN/100mL)	% Samples > 800 (MPN/100mL)	Minimum Concentration (MPN/100mL)	Maximum Concentration (MPN/100mL)
1507	26	N/A	30	19.2	1	3300
1474	48	N/A	23	8	10	1600

Notes:
1. N/A = not applicable as less than 10 samples collected within a 30-day period to evaluate

criteria.

Table 5. Summary of Total Coliform Monitoring Data

WBID	Number of Samples	30-Day Geometric Mean	% Samples > 2,400 (MPN/100mL)	Minimum Concentration (MPN/100mL)	Maximum Concentration (MPN/100mL)
1624	19	N/A	21.1%	400	5500

Notes:
1. N/A = not applicable as less than 10 samples collected within a 30-day period to evaluate criteria.

Violations of the fecal and total coliform criteria often occur in response to rainfall events. The National Oceanic and Atmospheric Administration (NOAA) collect meteorological data at numerous locations in Florida. Precipitation data collected at stations near the impaired WBIDs are superimposed on the water quality results to identify conditions when violations are occurring. Figure 2 shows the correlation between fecal coliform measured in 2003 in Rocky Creek and precipitation measured at a nearby NOAA cooperative station. This figure indicates coliform violations occur during wet weather events. The correlation between rainfall and coliform in the other impaired WBIDs are shown in Appendix A.

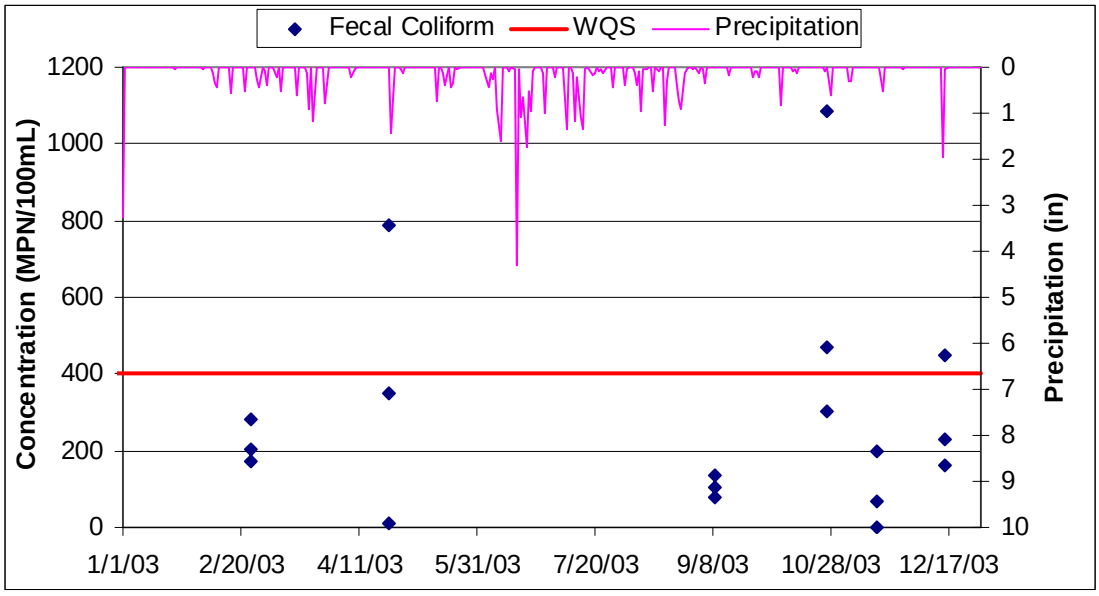

Figure 2. Fecal coliform in Rocky Creek and precipitation measured at Hillsborough State Park

5.2 SOURCE ASSESSMENT

An important part of the TMDL analysis is the identification of source categories, source subcategories, or individual sources of coliform bacteria in the watershed and the amount of pollutant loading contributed by each of these sources. Sources are broadly classified as either point or non-point sources.

A point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Point source discharges of industrial wastewater and treated sanitary wastewater must be authorized by National Pollutant Discharge Elimination System (NPDES) permits. NPDES permitted facilities discharging treated sanitary wastewater or stormwater (i.e., Phase I or II MS4 discharges) are considered primary point sources of coliform.

Non-point sources of coliform are diffuse sources that cannot be identified as entering a waterbody through a discrete conveyance at a single location. These sources generally, but not always, involve accumulation of bacteria on land surfaces and wash off as a result of storm events. Typical non-point sources of coliform include:

- Wildlife
- Agricultural animals
- Onsite Sewer Treatment and Disposal Systems (septic tanks)
- Urban development (outside of Phase I or II MS4 discharges)

The Watershed Characterization System (WCS), a geographic information system (GIS) tool, was used to display, analyze, and compile available information to characterize potential bacteria sources in the impaired WBIDs. This information includes land use, point source dischargers, soil types and characteristics, population data (human and livestock), and stream characteristics.

5.2.1 Point Sources

There are several point sources located in the drainage areas of the 303(d) listed stream segments that possess NPDES permits for discharges of treated sanitary wastewater; however, most of these facilities discharge to percolation ponds, spray fields, or deep injection wells. A wasteload allocation (WLA) is given only to NPDES facilities discharging to surface waters. These facilities are listed in Table 6. It should be noted that wastewater facilities permits authorize a discharge only if the applicant provides reasonable assurance that the discharge will not cause or contribute to violations of the water quality criteria. Under the Grizzle-Figg legislation (Chapter 403.086, F.A.C.), all domestic facilities with surface water discharges in the Tampa Bay Basin are required to treat the wastewater to at least advanced waste treatment (AWT) standards. Facilities that dispose of wastewater by means other than surface water discharge, such as through spray irrigation or underground injection wells, typically treat wastewater to less stringent secondary standards.

A review of permit conditions provided in EPA's Permit Compliance System (PCS) database (www.epa.gov/enviro) indicates domestic facilities have permit limits for fecal coliform bacteria only. A query of this database did not report permit violations from the facilities listed in Table 6. Based on this information effluent discharging from the facilities do not appear to cause or contribute to impairment in the listed WBIDs. Because of the ATW standards imposed on NPDES facilities in the Tampa Bay Basin, it is unlikely the effluent concentration of total coliform is significant in the discharge. For this reason, the NPDES facilities are not given a WLA for total coliform.

The coliform WLAs are calculated as both a maximum one-day load and a monthly average load using the facility's design flow and permit concentrations. The WLA expressed as counts/day represents the maximum load the facility can discharge on any one day during a 30-day period. A footnote to Table 6 expresses the WLA in terms of the maximum monthly load in units of counts/30 days. The WLA is calculated using Equation 1.

WLA = flow * concentration * conversion factor (Equation 1)
Where: flow = mgd
concentration = permit limits in units of MPN/100mL
conversion factor = (10^6 gal * 3.785 L/gal * 1000 ml/L) / 100 ml = 3.785 x 10^7

Table 6. NPDES Facilities Discharging into Watersheds of Impaired WBIDs

NPDES No.	FL0036820	FL0027821	FL0041670
Facility Name	Dale Mabry	River Oaks	NW Regional WWTP
Impacted WBID	1507	1507	1507
Discharge Point	Brushy Creek (see note 1)	Channel A	Channel A
Disposal Method	SW / LA	SW	SW/LA
Design Flow (MGD)	6	10	5
Permit Limits (counts/100mL)	86 (maximum); 14 (monthly median)	25 (maximum)	25 (maximum)
WLA (fecal coliform, MPN/day)[2,3]	1.95 x 10^{10}	9.46 x 10^9	4.73 x 10^9

Notes:

1. Brushy Creek (WBID 1498) is a tributary to Rocky Creek in northern portion of the Rocky Creek watershed.
2. WLA for fecal coliform represents maximum daily load based on facility design flow and one-day maximum permit concentration.
3. Monthly total coliform WLA for Dale Mabry facility is: 9.54 x 10^{10} MPN/30days (i.e., 6*14*3.785 x10^7 * 30day = 9.54 x 10^{10})
4. River Oaks and NW Regional WWTPs discharge pipes are located downstream of all monitoring stations near the pore point of the WBID; effluent from this facility does not impact water quality at the monitoring stations)
5. Disposal methods: SW = surface water; LA = land application

Municipal Separate Storm Sewer Systems (MS4s) may also discharge bacteria to waterbodies in response to storm events. Currently, large and medium MS4s serving populations greater than 100,000 people are required to obtain a NPDES stormwater permit. In March 2003, small MS4s serving urbanized areas were required to obtain a permit under Phase II stormwater regulations. An urbanized area is defined as an entity with a residential population of at least 50,000 and an overall population density of 1,000 people per square mile. MS4 municipalities covered under the NPDES Storm Water Program impacting coliform TMDLs addressed in this report are identified in Table 7.

The City of Tampa (FLS000008) is the only municipality within the impaired WBIDs covered under the Phase I MS4 permit. Hillsborough County Public Works (FLS000006) and Pinellas County Government (FLS000005) are also permitted under the Phase I MS4 program. Hillsborough County Environmental Protection Commission (EPC) has been monitoring water quality at 52 bay stations and 42 tributary stations on a monthly basis since the early 1970s. Bacterial trends at the monitoring stations tend to reflect rainfall levels and land use changes. EPC attributes improvements in domestic wastewater treatment, especially the reduction of surface water discharges from these facilities, changes in agricultural practices, and better management of stormwater runoff for the reduction of bacterial contamination in the Hillsborough County tributaries. EPC does not monitor water quality data in the WBIDs addressed in this TMDL.

Table 7. MS4 Areas In Watershed of Impaired WBIDs

MS4 Municipality	Impacted WBID	Notes
Hillsborough Co. Public Works	1507, 1474	Phase I MS4
Pinellas County Government	1474	Phase I MS4

Note: The cities of East Lake and Citrus Park are within the jurisdiction of Hillsborough County; the City of Keystone is within the jurisdiction of Pinellas County.

The WLA for the MS4 is expressed in terms of percent reduction. Given the available data, it is not possible to estimate loadings in units of MPN/day coming exclusively from the MS4 area. Although the aggregate wasteload allocation for storm water discharges is expressed in numeric form, percent reduction, based on the information available today, it is infeasible to calculate numeric WLAs for individual storm water outfalls because discharges from these sources can be highly intermittent, are usually characterized by very high flows occurring over relatively short time intervals, and carry a variety of pollutants whose nature and extent varies according to geography and local land use. For example, municipal sources such as those covered by these TMDLs often include numerous individual outfalls spread over large areas. Water quality impacts, in turn, also depend on a wide range of factors, including the magnitude and duration of rainfall events, the time period between events, soil conditions, fraction of land that is impervious to rainfall, other land use activities, and the ratio of storm water discharge to receiving water flow.

These TMDLs assume for the reasons stated above that it is infeasible to calculate numeric water quality-based effluent limitations for coliform for storm water discharges. Therefore, in the absence of information presented to the permitting authority showing otherwise, these TMDLs assume that water quality-based effluent limitations for storm water sources of coliforms derived from this TMDL can be expressed in narrative form (e.g., as best management practices), provided that (1) the permitting authority explains in the permit fact sheet the reasons it expects the chosen BMPs to achieve the aggregate wasteload allocation for these storm water discharges; and (2) the state will perform ambient water quality monitoring for coliform expressed as counts/day for the purpose of determining whether the BMPs in fact are achieving such aggregate wasteload allocation.

The percent reduction calculated for nonpoint sources is assigned to the MS4 as violations from both sources typically occur in response to storm events. Permitted MS4s will be responsible for reducing only the loads associated with stormwater outfalls which it owns, manages, or otherwise has responsible control. MS4s are not responsible for reducing other nonpoint source loads within its jurisdiction. All future MS4s permitted in the area are automatically prescribed a WLA equivalent to the percent reduction assigned to the LA. A WLA is given for both fecal and total coliform as reasonable potential exists for the MS4 to discharge both of these parameters.

5.2.2 Non-point Sources

5.2.2.1 Wildlife

Wildlife deposit bacteria with their feces onto land surfaces where it can be transported during storm events to nearby streams. The bacteria load from wildlife is assumed background, as the contribution from this source is small relative to the load from urban and agricultural areas. In addition, any strategy employed to control this source would probably have a negligible impact on obtaining water quality standards.

5.2.2.2 Agricultural Animals

Agricultural animals are the source of several types of coliform loadings to streams. Agricultural activities including runoff from pastureland and cattle in streams impact water quality. Livestock inventory from the 2002 Census of Agriculture for the counties encompassing the impaired WBIDs are listed in Table 8. Cattle, including beef and dairy cows, is the predominate livestock in these counties. Confined Animal Feeding Operations (CAFOs) are not known to operate in the impaired WBIDS. Based on the land cover distribution of the impaired WBIDs (see Table 2) the agricultural activities occurring in Hillsborough County are not within boundaries of he impaired watersheds.

Table 8. Livestock Inventory by County (source: NASS, 2002)

Livestock (inventory)	Hillsborough	Pinellas
Cattle and calves	66,501	71
Beef Cows	33,144	51
Dairy Cows	1,325	---
Swine	1,724	---
Poultry (broilers sold)	428	80
Sheep	793	(D)
Goats	1,764	---
Horses and Ponies	4,975	336

Notes: (D) – data withheld to avoid disclosing data for individual farms

5.2.2.3 Onsite Sewerage Treatment and Disposal Systems (Septic Tanks)

Onsite sewage treatment and disposal systems (OSTDs) including septic tanks are commonly used where providing central sewer is not cost effective or practical. When properly sited, designed, constructed, maintained, and operated, OSTDs are a safe means of disposing of domestic waste. The effluent from a well-functioning OSTD is comparable to secondarily treated wastewater from a sewage treatment plant. When not functioning properly, OSTDs can be a source of nutrient (nitrogen and phosphorus), pathogens, and other pollutants to both ground water and surface water.

The State of Florida Department of Health (www.doh.state.fl.us/environment/statistics) publishes septic tanks data on a county basis. Table 9 summarizes the number of septic systems installed since the 1970 census and the total number of repair permits issued between 1996 and 2001. The data does not reflect septic tanks removed from service.

Table 9. County Estimates of Septic Tanks and Repair Permits (FDEP, 2001)

County	Number of Septic Tanks (2002)	Number of Repair Permits Issued (1996 – 2002)
Hillsborough	100,483	1,651

County	Number of Septic Tanks (2002)	Number of Repair Permits Issued (1996 – 2002)
Pinellas	23,578	1,075

5.2.2.4 Urban Development

Fecal coliform loading from urban areas is attributable to multiple sources including storm water runoff, leaks and overflows from sanitary sewer systems, illicit discharges of sanitary waste, runoff from improper disposal of waste materials, leaking septic systems, and domestic animals.

In 1982, Florida became the first state in the country to implement statewide regulations to address the issue of nonpoint source pollution by requiring new development and redevelopment to treat stormwater before it is discharged. The Stormwater Rule, as outlined in Chapter 403 Florida Statutes (F.S.), was established as a technology-based program that relies upon the implementation of BMPs that are designed to achieve a specific level of treatment (i.e., performance standards) as set forth in Chapter 62-40, F.A.C.

Florida's stormwater program is unique in having a performance standard for older stormwater systems that were built before the implementation of the Stormwater Rule in 1982. This rule states: "the pollutant loading from older stormwater management systems shall be reduced as needed to restore or maintain the beneficial uses of water" (Section 62-4-.432 (5)(c), F.A.C.).

Nonstructural and structural BMPs are an integral part of the State's stormwater programs. Nonstructural BMPs, often referred to as "source controls", are those that can be used to prevent the generation of NPS pollutants or to limit their transport off-site. Typical nonstructural BMPs include public education, land use management, preservation of wetlands and floodplains, and minimizing impervious surfaces. Technology-based structural BMPs are used to mitigate the increased stormwater peak discharge rate, volume, and pollutant loadings that accompany urbanization.

5.3 Analytical Approach

The approach for calculating coliform TMDLs depends on the number of water quality samples and the availability of flow data. When long-term records of water quality and flow data are not available, the TMDL is expressed as a percent reduction. When limited water quality or flow data are available a mass balance approach is used to calculate the TMDL. Load duration curves are used to develop TMDLs when significant data are available to develop a relationship between flow and concentration. For the load duration curve TMDLs, the target is the acute criteria. The approach used to develop the coliform TMDLs are listed in Table 10. Details pertaining to the analytical approach are included in Appendix B. The target in the coliform TMDLs is the acute water quality standard.

Table 10. Approach for developing coliform TMDLs

Listed Waterbody	Parameter	Approach
Rocky Creek (1507)	Fecal Coliform	Load Duration Curve
Brooker Creek (1474)	Fecal Coliform	Load Duration Curve

Listed Waterbody	Parameter	Approach
Roosevelt Basin: Channel 2 (1624)	Total Coliform	Percent Reduction

5.3.1 Mass Balance Approach for TMDL Development

Load duration curves are based on the conservation of mass principle as defined in Equation 2.

Load = Concentration * Flow * Conversion Factor (Equation 2)

Where: Load = cfu/day
Flow = cfs
Concentration = MPN/100mL
Conversion Factor = (28.247 L/cf * 86400 sec/day * 1000mL/L)/100mL

For existing conditions, the sample concentration and an estimate of flow on the day of sampling is used to calculate the load. The allowable load, or TMDL, is calculated using the applicable water quality criterion. If a USGS flow gage operates in the WBID a flow duration curve is developed and the flow at various duration intervals is used to estimate the allowable load. Flows on ungaged streams can be extrapolated using a drainage area ratio or some type of regression analysis. The drainage area method is appropriate to estimate flows when the drainage area for the ungaged site is within about 0.5 to 1.5 times the drainage area of the gaged site (personal communications, USGS, 2002). When the locations of the monitoring stations and flow gage do not coincide, flows at the monitoring stations are estimated based on the drainage area ratio of the two sites.

5.3.2 Flow Duration Curves

The first step in developing load duration curves is to create flow duration curves. A flow duration curve displays the cumulative frequency distribution of daily flow data over the period of record. The curve relates flows measured at a monitoring station to a duration interval representing the percent of time flows are equaled or exceeded. Flows are ranked from low, which are exceeded nearly 100 percent of the time, to high, which are exceeded less than 1 percent of the time. Flow duration curves are limited to the period of record available at a gage. The confidence in the duration curve approach in predicting realistic percent load reductions increases when longer periods of record are used to generate the curves. Gages used to develop flow duration curves for the TMDL analysis are shown in Table 11. The flow duration curve for Rocky Creek is shown in Figure 3. Flow duration curves for other listed waterbodies are provided in Appendix B.

Table 11. Continuous flow gages located in impaired waterbodies

Stream Name	USGS Gage	Period of Record
Rocky Creek near Sulphur Springs FL	02307000	1/1/1953 – 9/30/2003
Rocky Creek at St Hwy 587 at Citrus Park FL	02306774	10/1/1985 - current
Brooker Creek near Lake Fern FL	02307323	10/1/1970 – 1/31/1994
Brooker Creek near Tarpon Springs FL	02307359	9/1/1950 – 9/30/2003

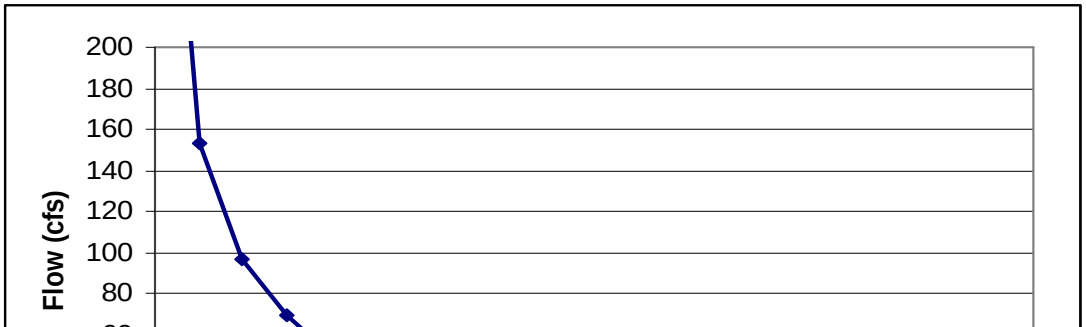

Figure 3. Flow Duration Curve for Rocky Creek (USGS 02307000)

5.3.3 Load Duration Curves

Flow duration curves are transformed into load duration curves by multiplying the flow values at each duration interval by the appropriate water quality criterion and a conversion factor. The line through these points is called the target line. Each point on the line represents the allowable load, or TMDL, at each interval. Existing loads are superimposed on the curve based on the duration interval of the flow used to calculate the existing load. Existing loads that plot above the target line indicate a violation of the water quality criterion, while loads plotting below the line represent compliance. The load duration curve for fecal coliform in Rocky Creek (WBID 1507) is shown in Figure 4. Load curves developed for other impaired waterbodies are provided in Appendix B.

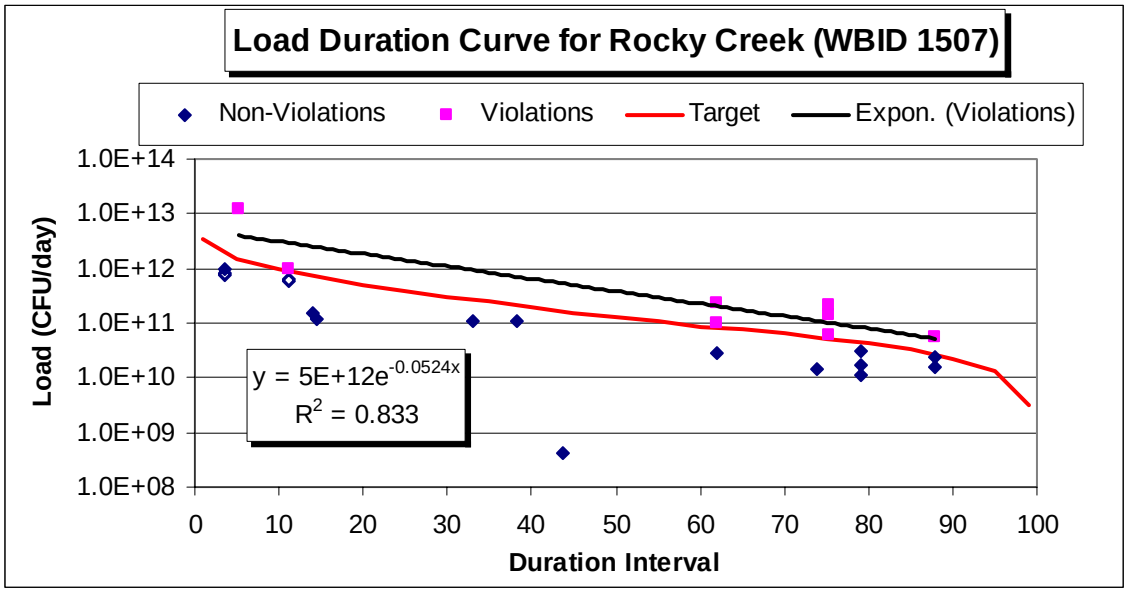

Figure 4. Load Duration Curve for Fecal Coliform in Rocky Creek (WBID 1507)

The positioning of monitoring data on the load duration curve provides an indication of the potential sources and delivery mechanisms of the pollutant. In general, violations occurring on the right side of the curve typically occur during low flow events and are indicative of continuous pollutant

sources, such as NPDES permitted discharges, leaking collection lines, or leaking septic systems. Livestock having access to streams could also be a source during low flow (livestock are not expected to be in the stream during high flows). Violations that occur on the left side of the curve occur during high flow events. Violations in this range are indicative of sources responding to rainfall events. As shown in Figure 4, water quality violations occur during dry conditions (i.e., flows exceeded between 60 and 90 percent of time) or after rainfall events preceded by an extended dry period.

Flow duration curve intervals can be grouped into broad categories, or zones, in order to provide insight about conditions and patterns associated with the impairment (Cleland, 2003). In these TMDLs, load duration curves are divided into five zones: one representing high flows, another for moist conditions, one covering median or mid-range flows, another for dry conditions, and one representing low flows. The use of duration curve zones provides a method for communicating technical information in a way that easily conveys conditions associated with problems.

If a sufficient number of samples plot above the allowable load line (i.e., more than four points), a trendline is drawn through the data violations. In the load curve application, trend lines are used to predict the load at other duration intervals. The type of line drawn through the data can have several shapes, ranging from linear (simplest form) to moving average. The type of the line chosen should result in a relatively high correlation factor, denoted by the variable R^2. The correlation factor provides an indication of how well the equation of the line represents the data. In general, high correlation factors are not associated with environmental data.

5.4 Development of Total Maximum Daily Loads

The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and recommends regulatory or other actions to be taken to achieve compliance with applicable water quality standards based on the relationship between pollution sources and in-stream water quality conditions. A TMDL can be expressed as the sum of all point source loads (Waste Load Allocations), non-point source loads (Load Allocations), and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$TMDL = \Sigma WLAs + \Sigma LAs + MOS$$

The objective of a TMDL is to allocate loads among all of the known pollutant sources throughout a watershed so that appropriate control measures can be implemented and water quality standards achieved. 40 CFR §130.2 (i) states that TMDLs can be expressed in terms of mass per time (e.g. pounds per day), toxicity, or other appropriate measure. TMDLs for the impaired waterbodies are expressed in terms of a percent reduction, and where possible, as loads in units of counts per day. When expressed as a load, the TMDL value represents the maximum one-day load the stream can transport over a 30-day period and maintain the water quality standards.

5.4.1 Critical Conditions

The critical condition for non-point source coliform loading is an extended dry period followed by a rainfall runoff event. During the dry weather period, coliforms build up on the land surface, and are washed off by rainfall. The critical condition for point source loading occurs during periods of low stream flow when dilution is minimized. Water quality data have been collected during both time

periods. Most violations occur during median to high flow conditions.

Critical conditions are accounted for in the load curve analysis by using the entire period of record of measured flows and all water quality data available for the stream. The critical condition is defined as the zone requiring the largest reduction. By achieving the reduction of the critical zone, water quality standards should be achieved during all other time periods.

5.4.2 Existing Conditions

Existing conditions are based on the instream water quality violations. When only a few samples exceed the numerical criterion, existing loads are based on the average values of the violations occurring in each zone. The trend line equation is also used to calculate the existing load at each duration interval. If water quality violations occur over several zones, the loads between the 10^{th} and 90^{th} duration interval were averaged to obtain a single value. Flows occurring less than 10 percent of the time were considered extreme flood conditions while flows occurring greater than 90 percent of the time were considered extreme drought conditions. Extreme flow conditions were not considered in the TMDL analyses unless these were the only violations measured in the WBID. It was not possible to construct a trend line through the limited data violations in Rocky Creek (see Figure 4); therefore, the existing load was estimated based on the median concentration of the data violations in the dry zone, or 1.01×10^{11} counts/day. Details on this calculation as well as calculations of existing loads for the other impaired WBIDs are provided in Appendix B.

5.5 Margin of Safety

There are two methods for incorporating a MOS in the analysis: a) implicitly incorporate the MOS using conservative model assumptions to develop allocations; or b) explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations. An implicit MOS was used in these TMDLs as only violations of water quality criteria are used to estimate the percent reduction necessary to achieve standards.

5.5.1 Determination of TMDL, WLAs, & LAs

The TMDL values represent the maximum daily load the stream can assimilate and maintain water quality standards. The TMDLs are based on the one-day maximum concentration of the parameter as specified in the Class III WQS and are expressed in units of counts per day. The TMDL value is reduced by the WLA, if any, to obtain the LA component. TMDL components for the impaired waterbodies as well as the percent reduction required to achieve the numerical criterion are provided in Table 12.

Table 12. Coliform TMDL Components

Stream Name	Parameter	WLA[1]		LA (cfu/day)	TMDL[3] (cfu/day)	Percent Reduction[4]
		Continuous (cfu/day)[5]	MS4 (reduction)			
Rocky Creek (WBID 1507)	Fecal Coliform	1.95×10^{10} (see note 5)	48%	3.33×10^{10}	5.28×10^{10}	48%
Brooker Creek (WBID 1474)	Fecal Coliform	N/A[2]	72	1.77×10^{10}	1.77×10^{10}	72%

Stream Name	Parameter	WLA[1]		LA (cfu/day)	TMDL[3] (cfu/day)	Percent Reduction[4]
		Continuous (cfu/day)[5]	MS4 (reduction)			
Roosevelt Basin: Channel 2 (WBID 1624)	Total Coliform	N/A	40%	40%	40%	40%

Notes:

1. WLA component separated into load from continuous NPDES facilities (e.g., WWTP) and load from MS4. Continuous discharge facilities have WLA units of cfu/day based on permit limits and design flow. MS4 load represented as percent reduction. If future residential development densities result in a change to the MS4 boundary, the MS4 will be required to meet the established TMDL in the form of BMPs.
2. N/A = not applicable
3. Margin of Safety is implicit and does not add to the TMDL value.
4. Overall reduction to achieve the most stringent of the acute criteria for fecal coliform and 2400 counts/100ml for total coliform.
5. WLA shown is for Dale Mabry WWTP as this impacts the analysis. Using permit limits, the monthly WLA for the Dale Mabry facility is 9.54×10^{10} cfu/30days. The River Oaks and NW Regional WWTP facilities effluent pipes are located in Channel A near the pour point of the WBID and do not impact the data used to develop the load duration curve. The WLAs for these facilities are provided in Table 6.

5.5.2 Waste Load Allocations

There are numerous NPDES permitted facilities discharging coliforms to surface waters in the Tampa Bay Basin; however, most of the facilities discharge to spray fields. Only facilities discharging directly into streams and MS4 areas are assigned a WLA. The WLAs are expressed separately for continuous discharge facilities (e.g., WWTP) and MS4 areas as the former discharges during all weather conditions whereas the later discharges in response to storm events.

Of the WBIDs addressed in this report, only Rocky Creek has NPDES facilities discharging directly into the stream. All facilities have permit limits that meet AWT standards, which are more stringent than water quality standards for Class III waters. Based on DMR data permit violations have not been reported, therefore, no reductions are required from these facilities.

In Table 12, the WLA assigned to the continuous discharge facilities (i.e., WWTP) is based on the one-day maximum limit specified in the permits (see Table 6). This load represent the maximum one-day load the facility can discharge in any 30-day period and maintain standards. Any future facility permitted to discharge fecal coliform bacteria in the Tampa Bay Basin will be required to meet AWT standards. Future facilities discharging at concentrations less than standard should not cause or contribute fecal coliform bacteria impairment in the watershed.

MS4s impact all of the WBIDs addressed in these TMDLs. The WLA assigned to the MS4 area is expressed in terms of percent reduction of coliform concentration required to attain standards. With the available water quality data it is not possible to isolate the loading discharging exclusively from the MS4 areas. Any future MS4 located within the watershed boundaries of the impaired WBIDs will be prescribed a WLA based on the percent reduction required in the TMDL.

5.5.3 Load Allocations

There are two modes of transport for non-point source fecal coliform bacteria loading into the stream. First, loading from failing septic systems and animals in the stream are considered direct sources to the stream, as they are independent of precipitation. The second mode involves coliform loadings resulting from accumulation on land surfaces transported to streams during storm events.

The positioning of the water quality data values on the load duration curve provide an indication of the mode of transport occurring during periods of violations. Most water quality violations in the impaired WBIDs are distributed on the left side of the curve, indicating violations occur during wet weather events. The LA components represented in Table 12 are calculated as the difference between the TMDL and the WLA components.

5.5.3 Calculation of Percent Reduction

The percent reduction necessary to achieve water quality standards is based on the more stringent of the dual acute criteria. Insufficient data are available to calculate the reduction using the chronic criteria (i.e., geometric mean), but meeting the acute criteria should result in attainment of standards during all times. Calculations of the TMDL and percent reductions for the coliform TMDLs are provided in Appendix B; an example using the fecal coliform TMDLs for Rocky Creek is explained below.

The fecal coliform TMDL for Rocky Creek was developed using a load duration curve. Violations were separated into zones of impairment as defined in Section 5.3.3. When multiple violations occur within a zone, the existing load is calculated as the median value of the load violations. The TMDL value is the allowable load at the midpoint of the zone. If one violation defines a zone, the TMDL value equals the allowable load at the interval where the violation occurs. The TMDL zones and reductions required to attain standards in Rocky Creek are shown in Table 13.

Table 13. Calculation of Fecal Coliform TMDL and reductions for Rocky Creek (WBID 1507)

Existing Loads expressed as cfu/day (median violation in each zone); TMDL is midpoint in range					
	High	Moist	Mid-Range	Dry	Low
	(0-10)	(10-40)	(40-60)	(60-90)	(90-100)
TMDL	1.50E+12	3.72E+11	1.27E+11	5.28E+10	1.37E+10
Existing Load	1.20E+13	9.91E+11		1.22E+11	
% Reduction	87.6%			56.8%	
Note: existing load includes contributions from both point and nonpoints sources					

Both point and nonpoint sources contribute fecal coliform load in Rocky Creek. The TMDL is separated into components by allocating a WLA to the NPDES facility based on design flow and concentration limits specified in the permit (see Table 6). The WLA is subtracted from the TMDL load to obtain the LA component. The MOS is assumed implicit in the analysis and does not impact the values assigned to the loads. If the NPDES facility is complying with its permit, the reduction required to achieve standards should be obtained from nonpoint sources. Rocky Creek is located within the Hillsborough County MS4 area and is assigned a percent reduction. TMDL components

for Rocky Creek are shown in Table 14.

Table 14. TMDL Components for Fecal Coliform in Rocky Creek (WBID 1507)

TMDL	5.28 x 10^{10} counts/day
WLA (continuous discharge)	1.95 x 10^{10} counts/day
WLA (MS4 discharge)	56.8% (reduction)
LA	3.33 x 10^{10} counts/day
MOS	Implicit
Percent Reduction	56.8%

The TMDL value can also be calculated using the trendline equation drawn through the data violations. In Rocky Creek violations are skewed toward the right side of the graph (see Figure 4). The trendline equation is used to calculate the existing load between the 60th and 90th duration interval. If violations occur over all flow intervals, it would be appropriate to calculate the existing load at all flow intervals. At each interval, the reduction is calculated between the allowable load and the existing load. The allowable load is calculated based on the 400 criteria and flow at the particular interval. The existing load at each interval is calculated using the trendline equation (see Figure 4 for trendline equation). In the trendline equation the parameter "x" in the equation represents the duration interval and the parameter "y" represents the load. Table 15 details the calculation of the TMDL and percent reduction for fecal coliform in Rocky Creek based on the trendline equation. The results from the trendline analysis compare favorable with the results from the zone analysis.

Table 15. Existing load and percent reduction in Rocky Creek using trendline equation

Check on TMDL and percent reduction values using trendline equation:
exponential line defines existing load: $y = 6E+12e^{-0.05666x}$

Interval	Existing Load	Allowable Load	Reduction
90	3.66E+10	2.25E+10	38.5%
85	4.86E+10	3.23E+10	33.5%
80	6.45E+10	4.21E+10	34.8%
75	8.56E+10	5.28E+10	38.3%
70	1.14E+11	6.36E+10	44.0%
65	1.51E+11	7.54E+10	50.1%
60	2.00E+11	8.81E+10	56.0%
55	2.66E+11	1.08E+11	59.5%
50	3.53E+11	1.27E+11	64.0%
45	4.69E+11	1.57E+11	66.6%
40	6.22E+11	1.96E+11	68.5%
35	8.26E+11	2.45E+11	70.4%
30	1.10E+12	2.94E+11	73.2%
25	1.46E+12	3.72E+11	74.4%
20	1.93E+12	4.89E+11	74.7%
15	2.56E+12	6.75E+11	73.7%
10	3.40E+12	9.49E+11	72.1%
5	4.52E+12	1.50E+12	66.9%

Median values between the 60th and 90th interval (range where violations occur)

TMDL = 5.28E+10 counts/day
Existing = 8.56E+10 counts/day
Reduction = 38.5%

5.5.4 Seasonal Variation

Seasonal variation was incorporated in the load curves by using the entire period of record of flow recorded at the gages. Seasonality was also addressed by using all water quality data associated with the impaired WBIDs, which was collected during multiple seasons.

5.6 Recommendations

Determining the source of bacteria in waterbodies is the initial step to implementing a coliform TMDL. FDEP employs the Basin Management Action Plan (B-MAP) as the mechanism for developing strategies to accomplish the necessary load reductions. Components of a B-MAP are:

- Allocations among stakeholders
- Listing of specific activities to achieve reductions
- Project initiation and completion timeliness
- Identification of funding opportunities
- Agreements
- Local ordinances
- Local water quality standards and permits
- Follow-up monitoring

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APPENDIX A WATER QUALITY DATA

List of Tables

List of Figures

Table A- 1. Guide to Water Quality Remark Codes (Rcode column in data tables)

Remark Code	Definition	Use in TMDL
A	Value reported is mean of two or more samples	Data included in analysis as reported
B	Result based on colony counts outside the acceptable range	Data included in analysis as reported
E	Extra sample taken in compositing process	Data included as average
I	The value reported is less than the practical quantification limit and greater than or equal to the method detection limit.	Data included in analysis as reported
K	Off-scale low. Actual value not known, but known to be less than value shown	Data included in analysis as reported
L	Off-scale high. Actual value not known, but known to be greater than value shown	Data included in analysis as reported
Q	Sample held beyond normal holding time	Data not used in analysis
T	Value reported is less than the criteria of detection	Data included in analysis if the reported value is below criteria; otherwise, reported value is not used in the analysis
U	Material was analyzed for but not detected. Value stored is the limit of detection.	Data not included in analysis
<	NAWQA – actual value is known to be less than the value shown	Data included in analysis
Z	Too many colonies were present to count (TNTC), the numeric value represents the filtration volume	Data not included in analysis

Table A- 2. Fecal coliform data collected in Rocky Creek (WBID 1507)

Date	Station	Time	Depth	Result	Rcode
4/9/91	112WRD 02307000	1055	.	250	
5/9/91	112WRD 02307000	1520	.	900	
5/29/91	112WRD 02307000	945	.	130	E
8/13/91	112WRD 02307000	1145	.	100	E
9/3/91	112WRD 02307000	1010	.	240	
12/4/91	112WRD 02307000	1105	.	4500	
1/29/92	112WRD 02307000	1030	.	470	
4/8/92	112WRD 02307000	1245	.	250	
5/13/92	112WRD 02307000	1230	.	150	
7/15/92	112WRD 02307000	1205	.	880	
8/19/92	112WRD 02307000	1130	.	760	
12/9/92	112WRD 02307000	1145	.	700	E
5/5/93	112WRD 02307000	1145	.	30	E
7/21/93	112WRD 02307000	1000	.	200	
8/4/93	112WRD 02307000	1000	.	100	
8/31/93	112WRD 02307000	1300	.	3400	
5/25/94	112WRD 02307000	1115	.	46	
9/21/94	112WRD 02307000	1145	.	80	
9/28/94	112WRD 02307000	1240	.	350	
12/14/94	112WRD 02307000	1145	.	180	E
6/14/95	112WRD 02307000	1145	.	260	E
7/26/95	112WRD 02307000	1500	.	3300	
8/15/95	112WRD 02307000	1130	.	1600	
9/6/95	112WRD 02307000	1130	.	500	
12/5/95	112WRD 02307000	1205	.	180	E
3/12/96	112WRD 02307000	1110	.	100	E
5/8/96	112WRD 02307000	1315	.	160	E
8/13/96	112WRD 02307000	1040	.	1100	
2/24/03	RO07 Rocky Creek at Gunn Hwy	11:30	0.5	280	
2/24/03	RO08 Rocky Creek at Mushinski Rd.	12:55	0.5	170	K
2/24/03	RO09 Rocky Creek at Linebaugh Ave.	14:35	0.5	205	
4/24/03	RO07 Rocky Creek at Gunn Hwy	10:25	0.5	790	B
4/24/03	RO08 Rocky Creek at Mushinski Rd.	11:15	0.5	350	B
4/24/03	RO09 Rocky Creek at Linebaugh Ave.	12:15	0.5	10	K
8/25/03	RO07 Rocky Creek at Gunn Hwy	11:12	0.5		
8/25/03	RO08 Rocky Creek at Mushinski Rd.	11:40	0.5		
8/25/03	RO09 Rocky Creek at Linebaugh Ave.	11:05	0.5		
9/9/03	21FLTPA 280223708234300	1240	0.20	105	
9/9/03	21FLTPA 280305908233390	1205	0.20	135	
9/9/03	21FLTPA 280357008233568	1045	0.20	80	
10/27/03	21FLTPA 280223708234300	1135	0.20	300	
10/27/03	21FLTPA 280305908233390	1045	0.20	1085	
10/27/03	21FLTPA 280357008233568	1020	0.20	470	
11/17/03	21FLTPA 280223708234300	1130	0.20	200	
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12/16/03	21FLTPA 280223708234300	1130	0.20	160	
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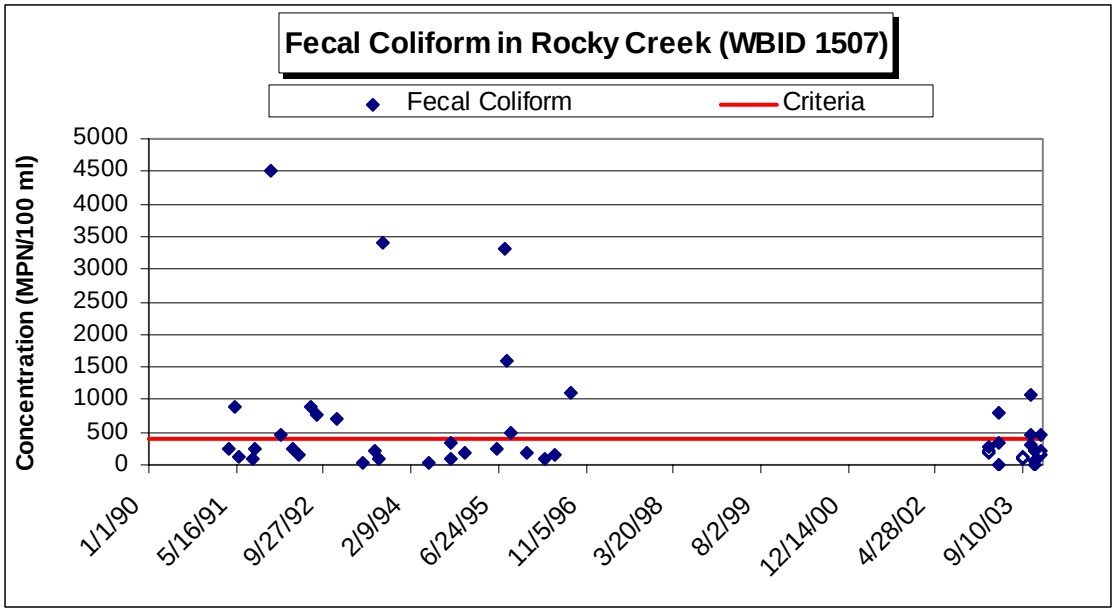

Figure A- 1. Fecal coliform measurements in Rocky Creek (WBID 1507)

Table A- 3. Fecal coliform data collected in Brooker Creek (WBID 1474)

Date	Station	Time	Depth	Result	Rcode
7/17/96	21FLPDEM04-02	1111	0.33	10	Z
3/27/96	21FLPDEM04-02	1053	0.33	80	
5/15/96	21FLPDEM04-02	1120	0.33	84	
10/30/96	21FLPDEM04-02	1028	0.33	140	B
4/16/96	21FLPDEM04-02	941	0.33	150	
12/17/96	21FLPDEM04-02	1046	0.33	310	
2/21/96	21FLPDEM04-02	945	0.33	400	L
6/19/96	21FLPDEM04-02	1014	0.33	400	
1/24/96	21FLPDEM04-02	1152	0.33	430	
8/7/96	21FLPDEM04-02	1048	0.33	760	
10/2/96	21FLPDEM04-02	946	0.33	1300	B
9/4/96	21FLPDEM04-02	1119	0.33	1600	B
5/15/96	21FLPDEM04-03	1217	0.33	52	B
3/27/96	21FLPDEM04-03	1149	0.33	84	
4/16/96	21FLPDEM04-03	1018	0.33	110	
7/17/96	21FLPDEM04-03	1151	0.33	160	
1/24/96	21FLPDEM04-03	1225	0.33	200	
2/21/96	21FLPDEM04-03	1018	0.66	210	
10/30/96	21FLPDEM04-03	949	0.33	240	
6/19/96	21FLPDEM04-03	1048	0.33	250	
10/2/96	21FLPDEM04-03	1026	0.33	280	
12/17/96	21FLPDEM04-03	1109	0.33	300	
9/4/96	21FLPDEM04-03	1144	0.66	450	
12/4/96	21FLPDEM04-03	1007	0.66	450	
8/7/96	21FLPDEM04-03	1010	0.66	590	

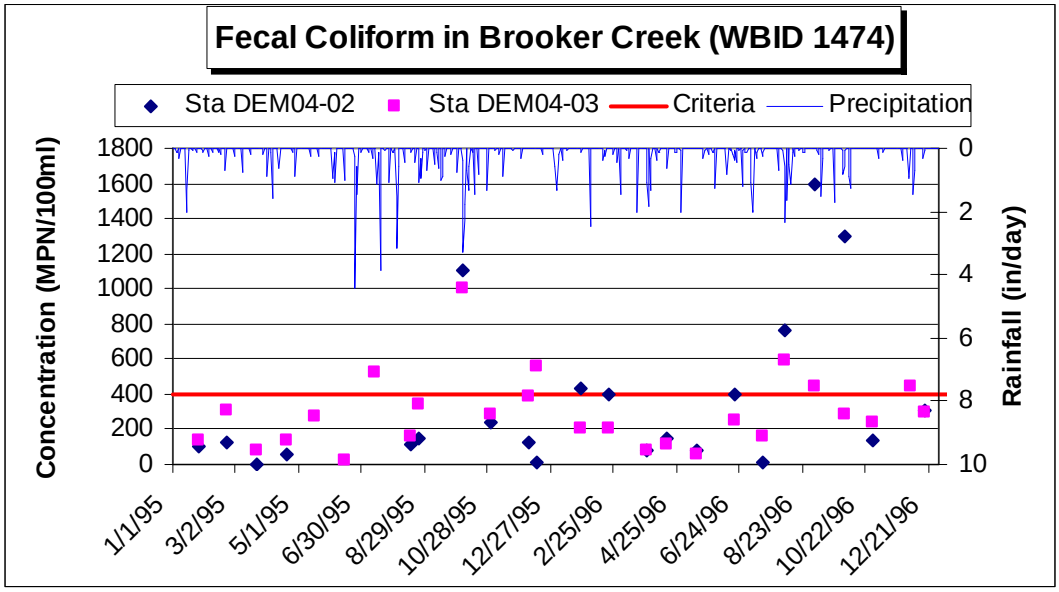

Figure A- 2. Fecal coliform in Brooker Creek and rainfall gage near Tarpon Springs, FL

Table A- 4. Total Coliform Measurements in Roosevelt Basin: Channel 2

WBID	Station	Date	Time	Depth	Total Coliforms	Rcode
1624	21FLPDEM23-01	1/11/95	918	0.33	3600	Q
1624	21FLPDEM23-01	2/8/95	946	0.33	3200	
1624	21FLPDEM23-01	4/12/95	930	0.33	4500	
1624	21FLPDEM23-01	5/2/95	838	0.33	1000	
1624	21FLPDEM23-01	6/7/95	939	0.33	800	B
1624	21FLPDEM23-01	6/28/95	908	0.33	1600	
1624	21FLPDEM23-01	8/9/95	917	0.33	700	B
1624	21FLPDEM23-01	8/29/95	904	0.33	1300	
1624	21FLPDEM23-01	9/27/95	905	0.33	1200	
1624	21FLPDEM23-01	11/29/95	944	0.33	5500	
1624	21FLPDEM23-01	1/17/96	922	0.33	1200	
1624	21FLPDEM23-01	2/7/96	921	0.66	1000	
1624	21FLPDEM23-01	3/13/96	915	0.33	700	B
1624	21FLPDEM23-01	4/3/96	855	0.33	1000	
1624	21FLPDEM23-01	5/8/96	913	0.33	1700	
1624	21FLPDEM23-01	7/10/96	1042	0.33	1400	
1624	21FLPDEM23-01	7/24/96	900	0.33	2400	
1624	21FLPDEM23-01	8/27/96	914	0.66	2000	
1624	21FLPDEM23-01	9/18/96	935	0.33	400	B
1624	21FLPDEM23-01	12/17/96	1019	0.33	2	Z
1624	21FLPDEM23-01	5/21/96	851	0.33	1	Z

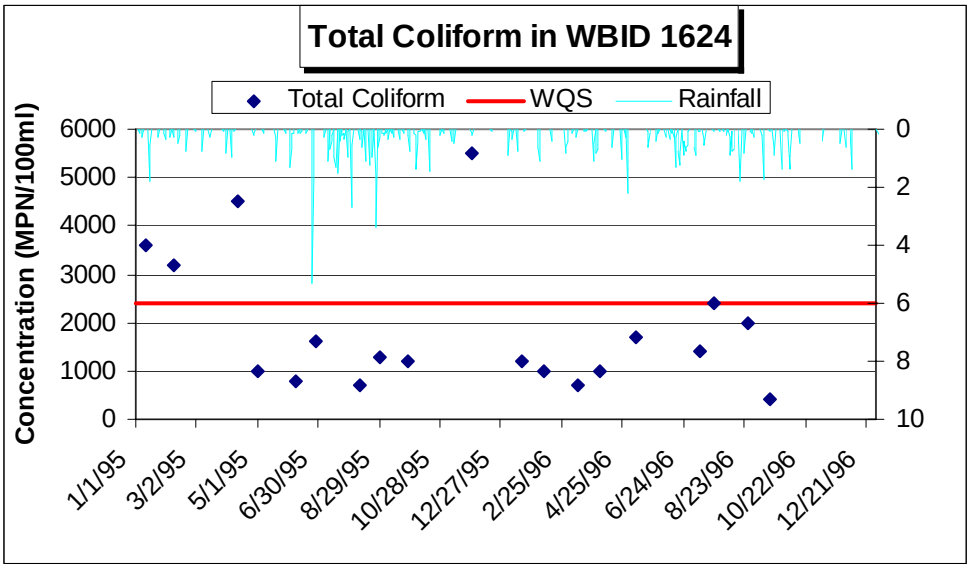

Figure A- 3. Total Coliform Measurements in Roosevelt Basin: Channel 2 (WBID 1624) and rainfall measured at Tampa International Airport

APPENDIX B CALCULATION OF COLIFORM TMDLS

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Constructing Flow Duration Curves

One of the shortcomings of using flow and load duration curves for data analysis is the method requires a significant amount of flow data. If continuous flow gages are not located in a WBID or if the locations of the water quality monitoring station and flow gage are not the same, techniques must be used to estimate flows. If a flow gage is operational in a WBID, flow at the time of sampling was assumed to approximate flow measured at the gage on the same day. Flow gages are not located within the Roosevelt Basin: Channel 2 WBID and due to tidal influences, the simple approaches for estimating flows as described in this section are not applicable to this WBID.

A common approach for estimating flow at a monitoring station that is at a different location than the gage, is to multiply the flow at the gaged site by the drainage area ratio between the two sites. This approach is used when the drainage area ratio of the ungaged site to the gaged site is within about 0.5 to 1.5. Two USGS gages are located within the Brooker Creek WBID. The USGS gage near the upstream monitoring station was discontinued in 1994 while the downstream gage remains active. Flows at the upstream gage (USGS 02307323) were estimated using a weighted drainage area approach and measured flows at the downstream gage (USGS 02307359). The drainage area ratio of the two sites is about 0.6, and is within the recommended range.

A flow duration curve displays the cumulative frequency distribution of daily flow data over the period of record. The confidence in the duration curve approach in predicting realistic load reductions increases when longer periods of record are used to generate the curves. The flow duration curve is easily generated in a spreadsheet, such as Excel, by using the percentile function and the flow record to generate the flow at a given duration interval. For example, at the 90th duration interval, the percentile function calculates the flow that is equal or exceeded 90 percent of the time. The flow duration curve for Brooker Creek at the downstream gage is shown in Figure B-1. Flows toward the right side of the plot are flows exceeded in greater frequency and are indicative of low flow conditions. Flows on the left side of the plot represent high flows and occur less frequently.

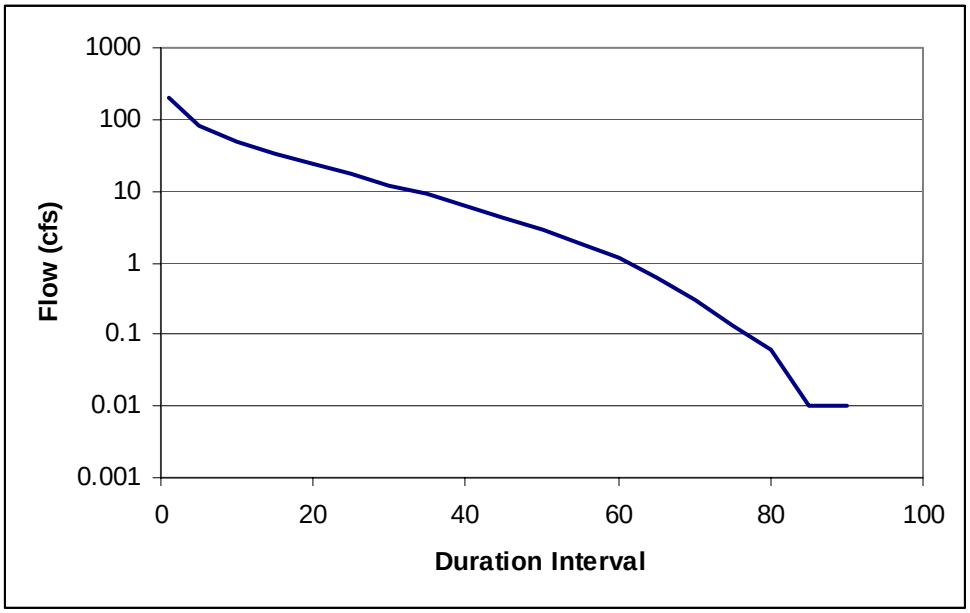

Figure B- 1. Flow duration curve for Brooker Creek at USGS 02307359

Multiple flow gages are located on Rocky Creek. A similar approach to estimate flows at discontinued gages as used in Brooker Creek is used in Rocky Creek to estimate flows. Most of the water quality samples in Rocky Creek are collected near the discontinued downstream gage (USGS 02307000). When flow measurements are not available at the downstream gage, flows are estimated in Rocky Creek using a weighted drainage area ratio with the upstream gage.

Constructing Load Duration Curves

The load duration curve is a visual display of the existing and allowable loads at each interval on the flow duration curve. The existing loads are based on the instream coliform concentrations measured during ambient monitoring and an estimate of flow at the station. Allowable loads, or TMDL, are based on the flow values at each interval on the flow duration curve and the applicable water quality criterion. Because insufficient data were collected to evaluate either the chronic criteria (i.e., geometric mean) the more stringent of the acute criteria (i.e., not to exceed percentage) is the target criterion in the fecal coliform TMDLs. Using the absolute value of the not to exceed criteria allows for an implicit margin of safety in the TMDLs.

The water quality samples collected at a monitoring station are separated into two groups depending on whether they violate the numerical target. Using Equation 2 (see Section 5.3.1), loads are calculated for each sample using the flow estimated or measured on the sampling day. Loads are expressed in units of counts per day to reflect the instantaneous criterion. The two groups of loads are plotted on the load duration curve with unique symbols. The positioning of the loads on the curve is based on the duration interval of the stream flow. Loads positioned above the allowable load line represent violations of the criterion while loads positioned below the line represent compliance with the criterion. The load duration curves developed for fecal coliform at the upstream and downstream monitoring stations are shown in Figure B- 2 and Figure B- 3, respectively.

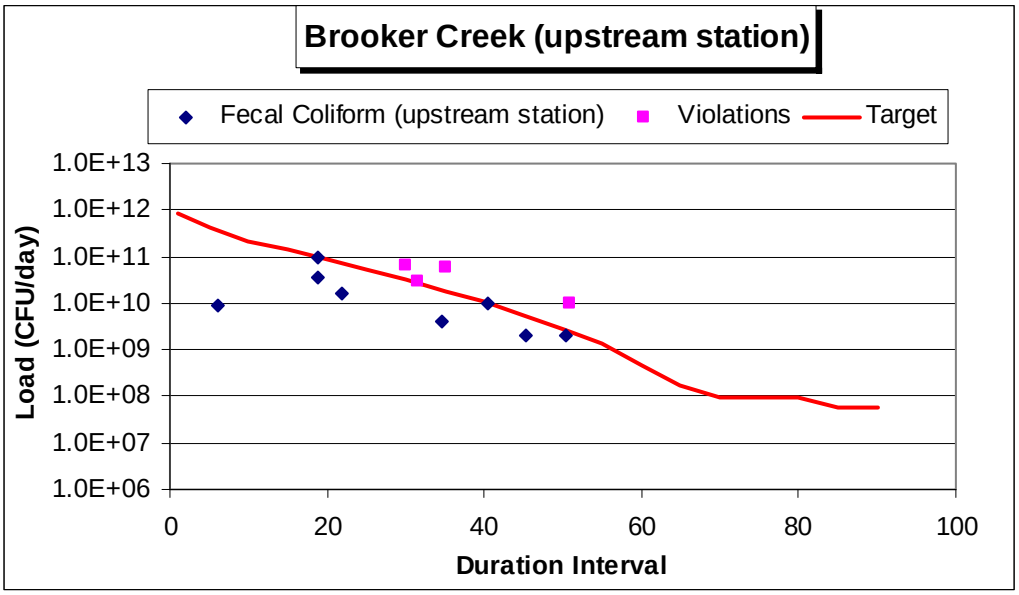

Figure B- 2. Load duration curve for fecal coliform In Brooker Creek (based on data and flow collected at station DEM04-02)

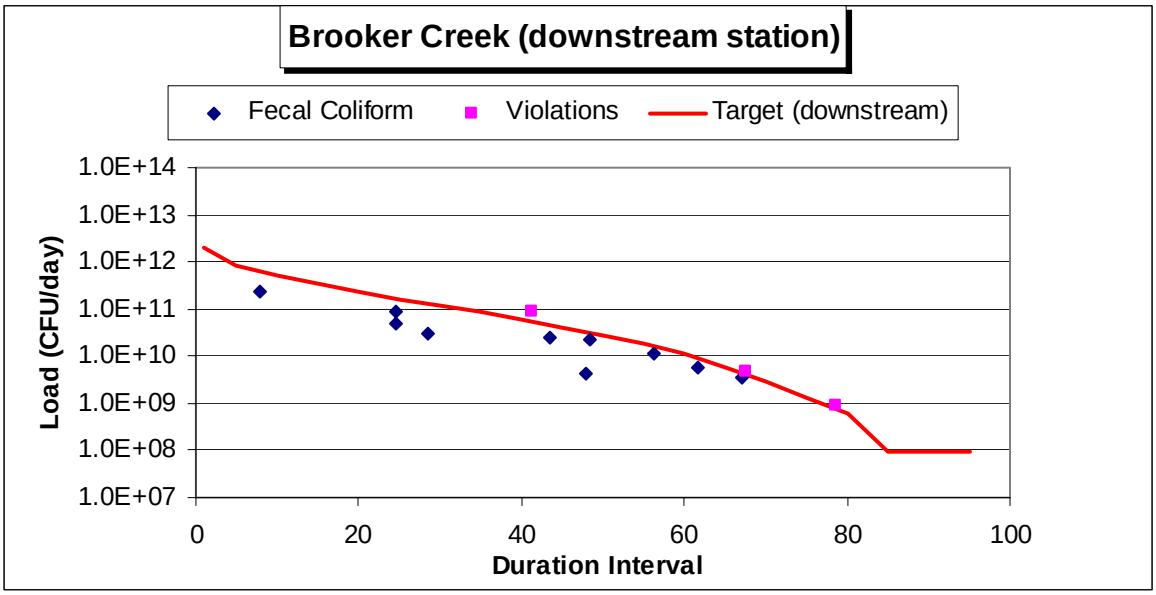

Figure B- 3. Load duration curve for total coliform in Brooker Creek (based on data and flow collected at station DEM04-03)

TMDL and existing loads are separated into zones of impairment. The zone requiring the highest reduction is selected for the TMDL. If five or more samples violate the criteria, the reduction required to achieve standards is also calculated using a trendline drawn through the data violations. The trendline equation is used to estimate violations over the range of intervals on the duration curve. The type of trend line used (i.e., linear, logarithmic, polynomial, etc.), reflected the best visual fit of the data and had the highest correlation coefficient (R^2 value). In the trend line equation, the x-variable is the duration interval.

The load calculated using the trend line equation is called the existing load. At each duration interval, if the existing load is greater than the target load, a percent reduction is required to meet the water quality criterion. The TMDL and percent reductions are calculated as the median value at the various recurrence intervals where a violation occurred.

The TMDL value is separated into WLA and LA components. If NPDES facilities are located in the watershed and discharge coliforms, the WLA component is assumed constant and is based on the facility design flow and one-day maximum concentration limit. The LA component is obtained by subtracting the WLA from the TMDL. The MOS is implicit and not assigned a value in the TMDL equation.

Calculation of the TMDL and percent reduction for fecal coliform in Brooker Creek at the upstream and downstream monitoring stations are shown Table B- 1 and Table B- 2, respectively. It was not possible to draw a trendline through the data violations. The upstream station required the highest percent reduction and was selected for the TMDL. The TMDL is based on loads and reductions in the moist zone as this zone represents most violations. In addition, the reduction required in the

moist zone is approximately equal to the reduction required of violations in the mid-range zone.

Table B- 1. Calculation of TMDL and percent reduction for fecal coliform in Brooker Creek (based on data collected at upstream station)

Existing Loads expressed as cfu/day (median violation in each zone); TMDL is midpoint in range

	High (0-10)	Moist (10-40)	Mid-Range (40-60)	Dry (60-90)	Low (90-100)
TMDL	4.11E+11	1.77E+10	2.66E+09	9.79E+07	5.55E+07
Existing		6.08E+10	9.54E+09		
Reduction		70.8%	72.1%		

Note: for moist zone, violations occur between 30 & 35th interval, set TMDL at 35th interval

Table B- 2. Calculation of TMDL and percent reduction for fecal coliform in Brooker Creek (based on data collected at downstream station)

Existing Loads expressed as cfu/day (median violation in each zone); TMDL is midpoint in range

	High (0-10)	Moist (10-40)	Mid-Range (40-60)	Dry (60-90)	Low (90-100)
TMDL	8.12E+11	1.66E+11	2.84E+10	1.27E+09	9.79E+07
Existing			9.64E+10	2.81E+09	
Reduction			70.6%	54.7%	

Percent Reduction

With the available data it was not possible to estimate flows in Roosevelt Basin: Channel 2 due to tidal influence from Old Tampa Bay. The TMDL for this WBID is expresses as a percent reduction based on the median value of water quality samples violating the total coliform criteria of 2400 MPN per 100ml. Water quality samples violating the target criteria and calculation of the TMDL are shown in Table B- 3.

Table B- 3. Calculation of total coliform TMDL for Roosevelt Basin: Channel 2 (WBID 1624)

Date	Station	Concentration	Reduction to criteria
1/11/95	21FLPDEM23-01	3600	33.3%
2/8/95	21FLPDEM23-01	3200	25.0%
4/12/95	21FLPDEM23-01	4500	46.7%
11/29/95	21FLPDEM23-01	5500	56.4%
		Median Value:	**40.0%**

APPENDIX C Fecal Coliform TMDL for Roosevelt Basin: Channel 2 (WBID 1624)

(prepared by FDEP and available as a separate file)

APPENDIX D Fecal and Total Coliform TMDL in Long Branch (WBID 1627)

(prepared by FDEP and available as a separate file)

APPENDIX E Fecal and Total Coliform TMDL in Delaney Creek (WBID 1605)

(prepared by FDEP and available as a separate file)